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Thinning Tolerant Hardwoods in Nova Scotia

J.C. Lees

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THINNING TOLERANT HARDWOODS IN NOVA SCOTIA

by

J.C. Lees

Maritimes Forest Research Centre
Fredericton, New Brunswick

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Une traduction francaise de ce rapport, intitulé "Eclairie de feuillus tolérants en Nouvelle-Ecosse", peut être mise à la disponibilité de quiconque en fait la demande.

ABSTRACT

A thinning study was begun in 1959 in Nova Scotia to improve quality in tolerant hardwoods. Yellow birch was favored in a birch, sugar maple, and beech mixture. Remeasurement in 1965 showed a worthwhile response to heavy thinning to release crop tree crowns. Subsequently birch crop trees suffered damage from porcupine feeding, exposure of emergent dominant crowns, and decay spreading from butt scars caused by logging. In a 1978 thinning of the original control, light, and heavily thinned plots, the then more vigorous sugar maple was favored and diseased beech and damaged yellow birch discriminated against. Chemical thinning was carried out in 1978 on one of the four (1960) treatment blocks. Beech and yellow birch were susceptible to treatment (60–100% crown kill). Sugar maple was less so (14–52%). Reassessment in 1980 showed that standing volumes were 60 $m^3 \cdot ha^{-1}$ on heavily thinned (1960) plots, 74 $m^3 \cdot ha^{-1}$ on lightly thinned (1960) plots and 83 $m^3 \cdot ha^{-1}$ on control (1960) plots. Total volume production to date has been 150 $m^3 \cdot ha^{-1}$ (heavy), 147 $m^3 \cdot ha^{-1}$ (light) and 188 $m^3 \cdot ha^{-1}$ (control). Stand volumes and stem quality will be assessed in 1988.

RESUME

Une étude de l'éclaircie a été entreprise en 1959 en Nouvelle-Écosse en vue d'améliorer la qualité des feuillus tolérants. Le bouleau jaune à été favorisé dans un mélange de bouleaux, d'érable à sucre et de hêtre à grandes feuilles. Les mesures prises en 1965 ont indiqué une réponse satisfaisante à la forte éclaircie pratiquée pour dégager les cimes des arbres d'avenir. Par la suite, les bouleaux ont subi des dommages causés par les porcs-épics, par l'exposition des cimes dominantes et par la pourriture s'étant développée à partir des blessures du pied infligées lors des travaux. En 1978, lors d'une éclaircie des parcelles témoins et traitées (à légère et forte éclaircies) originales, les érables à sucre alors plus vigoureux ont été favorisés au détriment des hêtres malades et des bouleaux jaunes endommagés. Une éclaircie chimique a été pratiquée en 1978 dans l'une des quatre parcelles traitées (1960). Le hêtre et le bouleau ont été durement touchés (60 à 100% de mortalité de la cime), mais l'érable à sucre l'a été moins (14 à 52%). Un réexamen en 1980 a indiqué un volume sur pied de 60 m^3/ha dans les parcelles fortement éclaircies (1960), de 74 m^3/ha dans les parcelles légèrement éclaircies (1960) et de 83 m^3/ha dans les parcelles témoins (1960). Les productions totales en volume jusqu'ici s'élèvent à 150, 147, et 188 m^3/ha, respectivement. Le volume des peuplements et la qualité des tiges doivent être évalués en 1988.

INTRODUCTION

The project "Thinning Immature Yellow Birch" was first proposed in 1958 by the original investigator, M.H. Drinkwater. He argued that the supply of sawlog quality birch[1] in Nova Scotia was dwindling and that sugar maple, and the disease-prone beech were competing more successfully for available sites (Drinkwater 1957).

Because yellow birch occurs in mixed hardwood stands along with white birch, red maple, poplars, beech, sugar maple, and scattered softwoods, Drinkwater proposed selecting yellow birch crop trees, releasing their crowns and thinning among other stems to maintain "full stocking", natural pruning, and complete crown cover. Crop tree release was to begin at age 30 years. Thinnings were to produce fuelwood. Reassessment was planned at age 50 and further thinning was then to be carried out.

A stand suitable for treatment was found on Crown land on Sugarloaf Mountain (elev. 190 m above sea level) in Cumberland County, Nova Scotia, and in the A-13 Cobequid Forest Section (Rowe 1972), (about 45°34'N, 63°49'W).

The district is part of the northern slope of the Cobequid "mountains", rolling hills that extend north to the Cumberland lowlands, and the Northumberland Strait between Nova Scotia and Prince Edward Island. The Sugarloaf Brook valley at the study area is narrow and deep and is joined by several intermittent streams that cross the slope. Exposure to wind is severe and tree height growth is limited except in sheltered valley sections.

Soils are brown gravelly sandy loams on till derived from granite-ortho-ferro-humic podzols of the Wyvern series (Nowland and MacDougall 1973). Moderately deep profiles occur on the gentle slopes, but the soil is shallow on the steep slopes. Drainage is rapid.

The forest is young second-growth mixed tolerant hardwoods originating from fire that burned in late May 1921 through recent mixedwood cutovers. In 1959, of the total basal area of 23 $m^2 \cdot ha^{-1}$, 63% was yellow birch, 25% sugar maple, and 12% beech. The stand was about 35 years old, 10 m in height with stem diameters ranging from 2 to 15 cm.

TREATMENTS

Crown release to favor yellow birch was completed in 1960, a remeasurement was carried out in 1965, and an assessment of the response to thinning in 1977.

In 1959, two intensities of thinning, light, 1 - 1.5 m between crowns; heavy, 2.5 - 3 m between crowns, and an unthinned control treatment had been assigned to three sections on each of five 4-acre (1.6-ha) blocks. By 1965 one block had been lost in power line right-of-way clearing (Fig. 1).

Between 1959 and 1977, the identified yellow birch crop trees had been severely damaged by porcupines feeding in the crowns and at the rootswell, where sap flowing from logging wounds may have attracted them.

Two tussock moth, Orgyia leucostigma (J.E. Smith), outbreaks during the period 1956-1976 caused extensive but temporary defoliation of sugar maple and white birch. Butt rot was common in logging-damaged stems. Increment borings in 1977 (Table 1) showed a decrease in radial growth of all species over the previous 10 years following an initial increased response during the first five years after treatment.

These considerations led to my decision in 1978 to thin all treatment plots

[1] Scientific and common species names are appended.

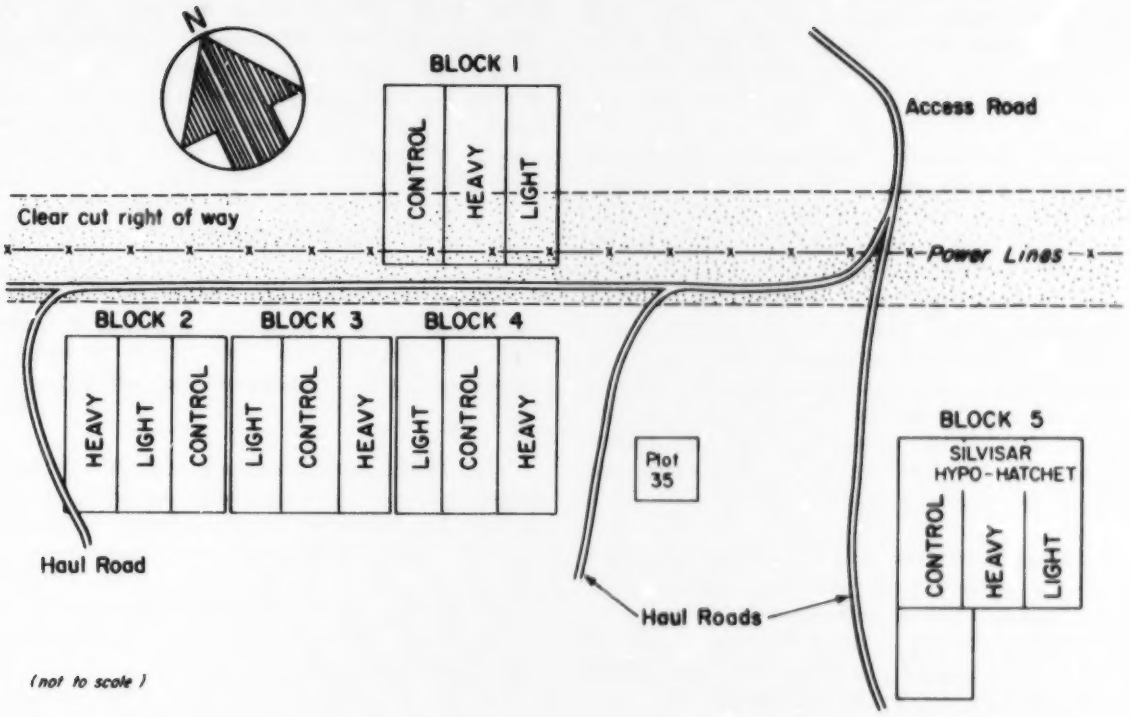

Fig. 1. Study block layout

Table 1. Mean radial increment of sample dominants before and after thinning

Thinning treatment (n)	5 years before 1960 thinning P.A.I. (mm)	5 years after 1960 thinning P.A.I. (mm)	10 years (1957-67) P.A.I. (mm)	10 years (1967-77) P.A.I. (mm)
Heavy (13)	1.22	2.04	1.72	1.54
Light (12)	1.1	1.6	1.53	1.51
Control (10)	1.32	1.54	1.41	1.16

*P.A.I., Periodic annual increment.

and their surrounds to a more or less uniform residual stocking, thus creating three thinning intensities, and to compare responses in 10 years (1988) using practical stocking guidelines for northern hardwoods (Leak et al. 1969) then in use in New England, and now proposed for Maritimes woodlot owners (Lees and Embree 1983).

The resulting treatments were

1. A heavy thinning in the 1960-control plots, discriminating against diseased beech, sprout clump maple (thinned to one stem), and porcupine-damaged birch.

2. A moderate thinning in the 1960 lightly-thinned plots, discriminating against beech and favoring maple.

3. A light thinning in the 1960 heavily-thinned plots, favoring sugar maple.

All potential crop trees were marked and released individually; the other stems were thinned to a 6 x 6-m spacing. Basal area removals ranged from 75% on some control plots, to 25% on plots previously heavily thinned. The crews, provided by the Nova Scotia Department of Lands and Forests, (NSDLF) were encouraged to make changes in the marking as required, and they tended to favor the better beech stems which, if removed, would create a gap in the canopy. The thinning is illustrated in Figs. 2, 3, and 4. Skid trails 4 m wide were cut at 40 m intervals using a chainsaw. The wood was cut and piled in 8-foot (2.4-m) lengths. Extraction was by a Gafner "Iron Mule" swing-frame forwarder, equipped with a grapple loader. Logging-damaged stems were then cut and removed. One heavy-thinning plot (35) was marked but left unthinned for a further comparison in 1988. One complete block (5) was chemically thinned by a NSDLF crew using "Silvisar 500" and a

Fig. 2. Before thinning, 1978

Fig. 3. The thinning crew

Fig. 4. After thinning

hack-and-squirt method (Figs. 5 and 6). Post-thinning assessments were completed in 1980.

RESULTS AND DISCUSSION

Chemical Thinning (1978)

In this block (5), the 1960 thinning, favoring yellow birch, resulted in best birch crop - tree growth after the heavy treatment, (height 19.3 m, diameter 18.4 cm) and smaller sizes in the unthinned stand (height 18 m, diameter 16.9 cm). Mean differences of 2 m in height and 2.3 cm in diameter resulted from the heavy thinning when all other species are considered. No wood products were generated by chemical thinning.

Table 2 shows some relative tree parameters, which may relate to a crown release effect, but chemical thinning was ineffectual as applied here. Despite an axe-wound for every inch (2.5 cm) of stem diameter (breast height), red maple and sugar maple survived the treatment. Birches and a few poplars although seriously damaged, persist. Crop trees

Fig. 5. Chemical thinning

Fig. 6. The hack-and-squirt method

Table 2. Crown-kill following chemical thinning (Block 5.)

Previous treatment	Treated trees Dbh cm	Ht m	Crown-kill %	Crop trees in stump sprout clumps Dbh cm	Ht m	Crown-kill %	All crop trees Dbh cm	Ht m
Control:								
Sugar maple	10.1	11.2	52	16.0	16.2	12	11.8	17.6
Yellow birch	11.0	11.6	76	16.9	17.8	32	16.9	18.0
Beech	9.3	9.0	100					
White birch	14.0	13.3	83					
Red maple	15.4	16.7	54	17.9	19.8	28	17.9	19.8
All	11.9	12.4	73	16.9	17.9	24	15.5	18.5
Heavy:								
Sugar maple	4.9	7.4	16	10.5	16.9	30	10.8	17.2
Yellow birch	9.7	10.1	60	15.9	21.2	34	18.4	19.3
Beech	5.6	4.9	84				-	-
Red maple							24.3	24.7
Mountain maple	5.5	7.0	100				-	-
All	6.9	7.4	65	13.2	19.1	32	17.8	20.4
Light:								
Sugar maple	7.6	8.7	14	19.2	18.9	15	20.8	19.2
Yellow birch	10.7	10.7	84	19.5	22.6	48	18.8	17.6
Beech	8.6	7.6	100	17.6	15 0	48	14.6	14.8
Red maple	11.8	10.7	61	19.1	15.9	9	18.6	15.9
All	9.7	9.4	65	18.9	18.1	30	18.2	16.9
Means	9.5	9.7	68	16.3	18.4	28	17.2	18.6

identified within sprout clumps, and not chemically treated, although damaged, suffered less crown damage than single-stem treated trees, and the treated trees in the clumps. Girdling of competing stems in clumps is an alternative which could be considered to avoid flashy chemical effects.

Chainsaw Thinning (1978)

In 1979, 178 cords (645 m^3) of wood were salvaged from the 18 acres (7.3 ha) thinned, i.e. approximately 10 cords per acre (89.6 $m^3 . ha^{-1}$). While thinning cost $60.87 per cord ($16.80/m^3), stand improvement assistance was available through the NSDLF district office under the current Federal-Provincial Development Agreement, and the net cost was $28.31 per cord ($7.81/m^3). At the time, the wood was worth $30 per cord ($8.28/m^3) piled on the main haul road (Fig. 7), and was sold as fuelwood. Drinkwater does not record any wood volumes generated by the thinning in

1960, and a large percentage of the small stems had been left lying in the stand.

Table 3 presents the stand growth responses to date. Basal area control was used in 1978 to ensure that the dominant canopy was maintained. Stem numbers had decreased dramatically in the control plots since the interim assessment in 1965 (by 1120/ac., 2768/ha). This self-thinning process had been accelerated by porcupine feeding, tussock moth defoliation, and wind damage previously noted. Control plot trees were of poor form, and branchy with irregular crowns. Clear bole percentages on selected crop trees were 38 (control), 46 (light), and 54 (heavy), and it was doubted whether control plot crop tree crowns would respond to thinning.

However, 1980 records show a uniformity of residual stand basal area, mean diameter, and stem numbers which is a tribute to the thinning crew. Values are illustrated on the basal area control chart (Fig. 8).

L.O. Safford, the author of the stocking guide for birch, said

> "Young stands of natural reproduction contain large numbers of small trees. With age, the trees grow larger and competition-induced mortality reduces their numbers. The stocking chart shows the relationship between number of trees, tree size (mean stand diameter), and stand density (basal area). The area of the chart marked by the A line and above represents the course of development for fully stocked, natural unmanaged stands. Stands with stocking above the A line are considered overstocked.
>
> Individual trees grow slowly and require a long time to progress to the larger sizes of maturity. These fully stocked stands produce the greatest total quantities of biomass.
>
> Increasing the growing space available to individual trees by thinning allows the individual tree to grow faster, but may reduce the total production. The aim of management is to maintain the required number of trees of desired species, form, and quality per unit area to maximize total value production of the desired product.
>
> Stands with stocking level at or above the B line are adequately stocked and can fully occupy the site. Total growth per unit area varies relatively little among stands with basal areas near the B line. The B line represents the stocking level below which competition-induced mortality is minimized.
>
> Depending on the number of quality stems available, thinning treatments can be applied to reduce stocking level anywhere between the A and B lines. If there are markets for small-size material that would make frequent entries into the stand possible, then each thinning should reduce stocking part way to the B level. For less frequent entries, stocking should be reduced to the B level in one or two treatments."

Fig. 7. The product, 8-ft fuelwood at roadside

Table 3. Stocking in tolerant hardwoods thinned in 1960 and 1978

		No. of trees		Basal area		Dbh		Percentage of basal area			
		ac^{-1}	ha^{-1}	ft^2	m^2	inch	cm	Yellow birch	Sugar maple	Beech	Other
Light thinning											
Before thinning	(1959)	2939	7262	110	25	2.6	6.6	43			
After thinning	(1960)	1733	4282	65	15	2.6	6.6	56			
Interim	(1965)	1614	3988	67	15	2.7	6.8	58	15	25	2
Before thinning	(1978)	1519	3753	110	25	3.6	9.1	69	18	13	-
After thinning	(1980)	349	862	53	12	5.3	13.5	73	20	7	-
Before thinning, crop trees	(1978)	150	371	36	8	6.6	16.8	78	22	-	-
After thinning, trees >4in. (10cm) dbh	(1980)	262	647	57	13	6.3	16.0	72	22	6	-
Heavy thinning											
Before thinning	(1959)	2858	7062	111	25	2.7	6.9	38			
After thinning	(1960)	1665	4114	64	15	2.6	6.6	46			
Interim	(1965)	1522	3761	64	15	2.7	6.9	50	17	31	2
Before thinning	(1978)	1178	2911	114	26	4.2	10.7	45	25	29	1
After thinning	(1980)	318	786	45	10	5.1	13.0	63	29	8	-
Before thinning crop trees	(1978)	199	492	33	8	5.5	14.0	83	17	-	-
After thinning, trees >4in. (10cm) dbh	(1980)	215	531	46	11	6.3	16.0	63	30	7	-
Control (thinned 1978)											
Initial	(1960)	2784	6879	81	19	2.3	5.8	65			
Interim	(1965)	2297	5676	90	21	2.7	6.8	54	18	27	1
Before thinning	(1978)	1177	2908	130	30	4.5	11.4	63	27	10	-
After thinning	(1980)	360	890	57	13	5.4	13.7	62	33	5	-
Before thinning crop trees	(1978)	215	531	43	10	6.1	15.5	64	33	3	-
After thinning, trees >4in. (10cm) dbh	(1980)	274	677	59	14	6.3	16.0	61	34	5	-

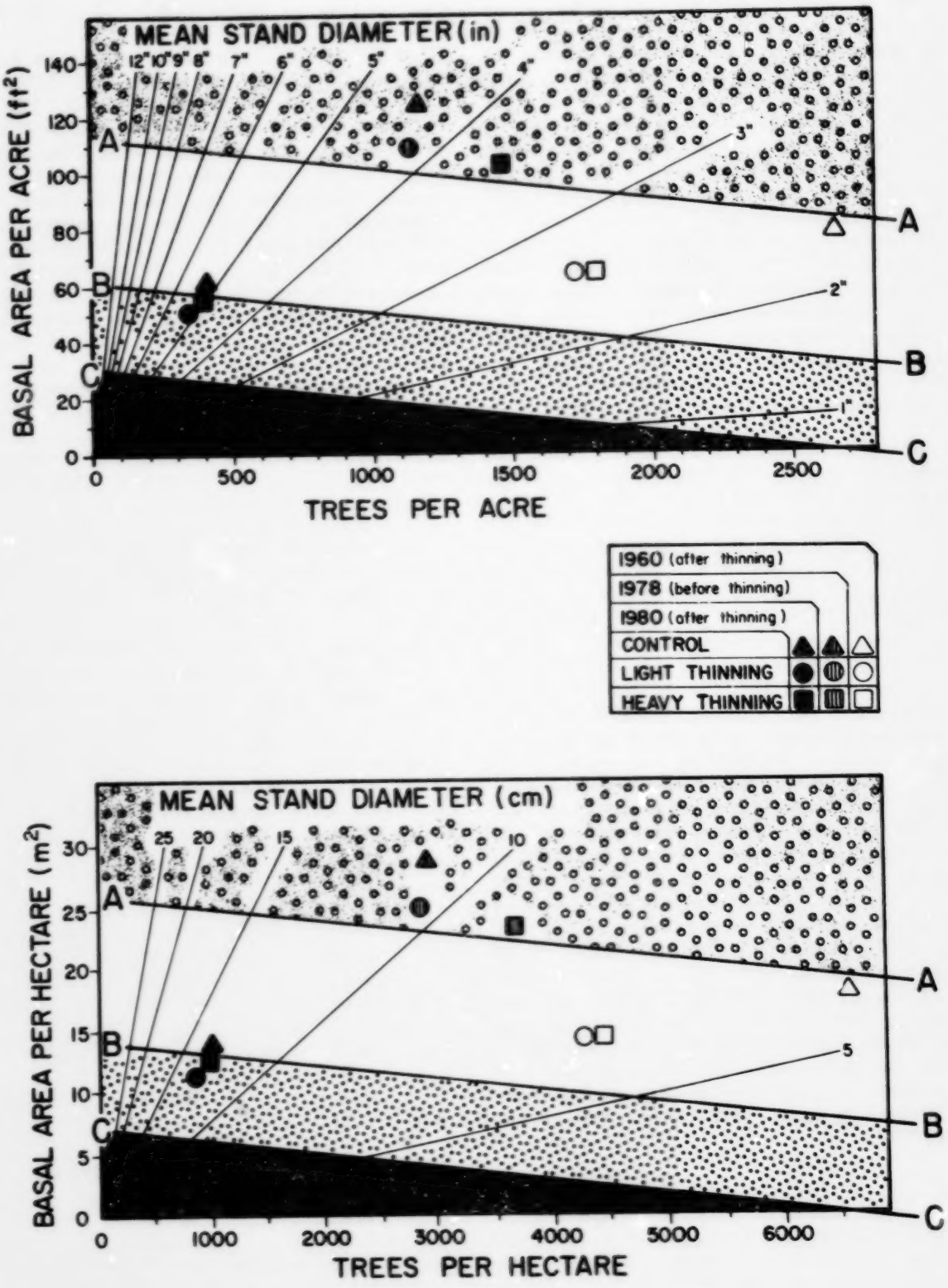

Fig. 8. Basal area control chart.

As a percentage of the basal area, yellow birch and sugar maple have steadily increased in the stands thinned in 1960, and beech has declined. In the control stands thinned in 1978, yellow birch remains steady, sugar maple increased from 18 to 33%, and beech declined naturally from 27% in 1965 to 10% in 1978 before thinning, and to 5% after thinning.

Table 4 shows estimates of total standing volumes derived from the basal area, quadratic mean tree diameter (Table 5) and mean height of dominant sample trees for each plot (Table 6); and introduces a discussion of the effectiveness of the 1960 thinnings.

When 1978 thinnings were added to standing volumes in 1980, the original control plots produced 188 $m^3.ha^{-1}$, light thinning 147 m^3, and heavy 150 m^3. Since no product was generated in 1960, it is questionable whether these 30-year-old hardwood stands were suitable for treatment at that time. The diseased beech occupied valuable space useful for the growth of the other species, and should be removed in thinnings, but precommercial or noncommercial thinning is difficult to justify in terms of total volume production. A market for whole-tree chips would change this picture, but the shallow soils on the steep slopes and the exposed crest of the hill at Sugarloaf may not be the best sites on which to examine cost-effectiveness of tolerant hardwood thinning. Soil chemical analyses on samples collected in 1982 (appended) showed that while major nutrients were not deficient, they were available at low levels in the rooting zone at 20-30 cm depth, pH was low (4.6), and higher nutrient values at 0-10 cm were probably attributable to hardwood litter decomposition and comminution in situ, and not to the parent material.

CONCLUSION

This is an important demonstration, for the Maritime Provinces, of thinning in tolerant hardwoods. In 1957, Drinkwater correctly predicted the shortage of quality hardwood logs. He probably could not have guessed at the recent increases in domestic fuelwood consumption - a market for thinnings, and the availability of thinning subsidies. There is now an appropriately treated 22-acre (8.9-ha) stand of mixed tolerant hardwoods. It is 56 years old, thinned at ages 31 and 51 years. Both thinnings produced fuelwood in today's terms, probably sufficient to cover the costs of the operation. The 1978-79 thinning crew, which had no previous experience of this type of treatment, went on to complete other successful thinnings on Crown lands.

Thinning is now a common practice in the three Maritime Provinces, especially on private woodlots. The operation is usually cost-shared with government, and there is interest in results from "older" trials such as this. Reassessment of the Sugarloaf plots for further thinning is planned for 1988. At that time, it will be important to evaluate stem quality, and total "value production" - the original study objective, as well as total volume production.

Table 4. Total standing volume estimates, ($m^3.ha^{-1}$)

	After thinning 1960	Interim 1965	Removed 1978	After thinning 1980	Total volume production 1980
Heavy	63	68	90	60	150
Light	68	71	73	74	147
Control	84	102	105	83	188

Table 5. Mean diameter of selected dominant sample trees (cm)

		After thinning 1960	Interim 1965	After thinning 1980
Heavy	Yellow birch	10.4	12.5	18.2
	Sugar maple	9.9	11.6	16.5
	Beech	9.1	11.1	18.3
	All (n)	10.2 ± 2.5 (393)	12.3 ± 2.7 (360)	17.4 ± 2.5(76)
Light	Yellow birch	10.3	11.8	18.0
	Sugar maple	10.6	11.5	19.1
	Beech	9.8	12.1	17.2
	All (n)	10.3 ± 2.5 (393)	11.8 ± 2.7 (398)	18.3 ± 3.3(89)
Control	Yellow birch	10.5	11.8	17.4
	Sugar maple	10.8	12.1	17.5
	Beech	9.6	10.7	18.1
	All (n)	10.4 ± 2.3 (469)	11.7 ± 2.6 (441)	17.5 ± 3.3(89)

Table 6. Mean height of selected dominant sample trees (m)

	Species	After thinning 1960	Interim 1965	After thinning 1980
Heavy	Yellow birch	10.2	11.1	13.3
	Sugar maple	10.5	11.3	13.3
	Beech	8.7	9.6	13.8
	All (n)	10.0 ± 4.8 (396)	10.0 ± 4.2 (349)	13.3 ± 1.3(76)
Light	Yellow birch	10.6	11.2	13.7
	Sugar maple	10.3	11.3	14.5
	Beech	9.0	9.7	14.8
	All (n)	10.5 ± 4.8 (396)	11.1 ± 4.4 (394)	13.9 ± 1.3(89)
Control	Yellow birch	10.5	11.4	14.7
	Sugar maple	10.4	11.5	14.8
	Beech	9.2	9.7	14.8
	All (n)	10.2 ± 4.9 (482)	11.3 ± 4.8 (445)	14.8 ± 1.2(89)

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SPECIES NAMES

Trembling aspen	Populus tremuloides Michx.
Largetooth aspen	Populus grandidentata Michx.
Grey birch	Betula populifolia Marsh.
White birch	Betula papyrifera Marsh.
Yellow birch	Betula alleghaniensis Britton
Red maple	Acer rubrum L.
Sugar maple	Acer saccharum Marsh.
Mountain maple	Acer spicatum Lam.
American beech	Fagus grandifolia Ehrh.

APPENDIX

Soil samples from the Sugarloaf thinning area (5 bulked samples from each sample depth and location)

Location	Depth cm	pH	Ca	K	Mg	P	Exch.cap.	OM	N
			me/100g			ppm	me/100g	% by wt	
Top,back	0-10	4.7	0.11	0.06	0.04	10.5	8.89	6.5	0.15
	10-20	4.1	0.6	0.09	0.28	9.13	13.16	8.5	0.22
	20-30	5.0	0.17	0.04	0.04	6.13	8.18	5.6	0.11
Plot 35 (Control)	0-10	4.3	0.5	0.09	0.25	6.13	12.1	8.09	0.21
	10-20	4.6	0.17	0.04	0.05	5.5	8.89	6.07	0.13
	20-30	4.6	0.14	0.04	0.05	3.5	7.83	4.84	0.1
Front line	0-10	4.2	1.02	0.14	0.41	9.38	11.75	9.7	0.25
	10-20	4.3	0.4	0.1	0.2	4.75	13.52	8.77	0.28
	20-30	4.6	0.14	0.07	0.08	5.5	7.84	5.27	0.16